PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G02C 7/04

A1

(11) International Publication Number: WO 98/53360

(43) International Publication Date: 26 November 1998 (26.11.98)

(21) International Application Number: PCT/GB98/01466

(22) International Filing Date: 21 May 1998 (21.05.98)

(30) Priority Data:
9710781.7 23 May 1997 (23.05.97) GB

(71) Applicant (*for all designated States except US*): ASPECT VISION CARE LTD. [GB/GB]; South Point, Hamble, Southampton SO31 4RF (GB).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): DE CARLE, John, Trevor [GB/GB]; Lowicks House, Sandy Lane, Rusmoor, Tilford, Farnham, Surrey GU10 2EX (GB).

(74) Agent: WOODCRAFT, David, Charles; Brookes & Martin, High Holborn House, 52/54 High Holborn, London WC1V 6SE (GB).

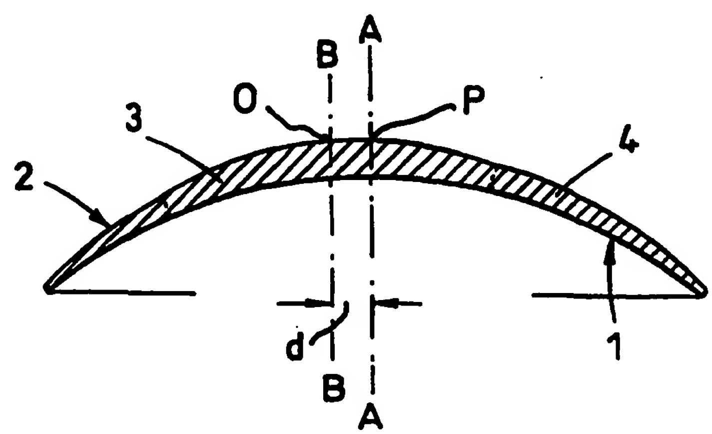
(81) Designated States: CA, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: DECENTERED BIFOCAL CONTACT LENSES

(57) Abstract

Multifocal contact lenses are disclosed having a circular first zone (3) intended for near or distance vision and an annular second zone (4) surrounding the first zone and intended for the other of near or distance vision. The optical axis B–B of the lens is displaced with respect to the geometric axis A–A so that in use the lens is decentered nasally.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

DECENTERED BIFOCAL CONTACT LENSES

This invention relates to multifocal contact lenses, and in particular to bifocal contact lenses.

Many attempts have been made to design a fully satisfactory bifocal contact lens. However, most designs are essentially a compromise and result in relatively poor near or distance vision. A common problem found by optometrists is that a bifocal lens which gives reasonably good reading vision results in poor distance clarity. It has been thought that this problem was caused by discontinuities in the lenticular surfaces at the boundaries between the different vision zones. Although there is an improvement when the lens surfaces of the zones are cut and polished so as to merge smoothly into one another, the above problem still remains.

The present invention is based on that observation that when a bifocal contact lens is displaced nasally in an average person, the vision, especially the distance vision, improves.

According to one form of the present invention, therefore, there is provided a multifocal contact lens which comprises a generally circular first vision zone intended for distance or near vision and an annular second vision zone surrounding said first vision zone and intended for the other of near or distance vision, wherein in use the optical axis of the first zone is displaced nasally with respect to the geometric axis of the lens.

Preferably, the first circular vision zone is a distance vision zone and the adjacent annular surrounding zone is a near vision zone. A more complex lens may include further annular zones surrounding the first annular zone and these zones may be alternately distance and near vision zones. Instead of having zones of only two focal lengths, multi-focal lenses may be constructed by providing a multiplicity of zones which cover three or more focal lengths.

Because it is important that the optical axis of at least the inner vision zone of the lens is displaced or decentered nasally, the lenses of this invention will normally incorporate some kind of retaining means which will ensure the desired orientation on the lens.

This can be achieved by known devices and procedures. In essence, these are as follows:-

1. Machining the lens with a vertical prism so as to increase the mass of the lens in the lower segment.

2. A 'slab off' technique. This method is conventionally used for ensuring the correct orientation of toric lenses. The lens is thinned at the top and bottom, e.g. by machining or polishing over arcuate portions of the lens.

3. Truncation. The lens can be truncated at the bottom to cause the lens to sit with the truncated portion downwardly. This technique can be combined with a prism.

4. The lens may be manufactured with a thicker area in the lower part of the lens. Although lenses of this shape are difficult to produce on a lathe, it becomes the preferred system if the lens is moulded.

Lenses of the present invention may operate by refraction and/or diffraction, although lenses which operate at least partly by refraction are preferred. Diffraction is conveniently employed to apply a plus correction for near vision to a lens in which the distance vision is corrected by the power curve of the lens. An example of such a lens and a method of manufacture is described in US Patent No. 4637697, the disclosure of which is specifically incorporated herein by reference.

The invention will now be illustrated by the accompanying drawings of one embodiment of a bifocal lens in accordance with the invention.

In the accompanying drawings:-

Figure 1 is a plan view of a bifocal lens in accordance with the invention,

Figure 2 is a cross-section on the line X-X in Figure 1,

Figure 3 is a cross-section on the line Y-Y in Figure 1, and

Figure 4 is a plan view of a second embodiment of a bifocal lens in accordance with the invention.

Referring to Figures 1 to 3 of the drawings, the lens has a base curve 1 cut to a profile which corresponds to the patient's cornea and a power curve 2 which determines the optical power of the lens. The power curve is machined with a central circular area 3 which forms one vision zone having a first power and an annular surrounding area 4 which forms a different vision zone having a second power. Preferably, zone 3 has a power appropriate for distance vision and zone 4 a power suitable for near vision. Differences in power are attained by the relative steepness of the portions of the power curve forming the zones. Although not preferred, the base curve may be shaped to provide the differences in power or contribute to the differences in power of the two vision zones.

As can be seen best in Figure 1, the point P represents the point through which the geometric axis A-A passes. In Figure 1, P represents the geometric centre of the lens. Zone 3 is displaced or decentered to one side of the lens so that when the lens is worn, its optical axis B-B passing through point O is displaced nasally when the lens is centered geometrically on the cornea. The optimum degree of displacement d varies with patients but is normally in the range of 0.5 to 1.5 mm, e.g. about 1 mm.

In order to ensure that the lens is oriented correctly on the cornea, the lens is formed with a thicker portion 6. This thicker portion tends to retain the lens on the cornea in the orientation shown in Figure 1 and preferably also acts to return the lens to this orientation if it becomes rotationally displaced during wearing.

Figure 4 shows a bifocal lens which is the same in most respects as the lens shown in Figures 1 to 3. The embodiment of Figure 4 differs from the first embodiment only in the retaining means for maintaining the lens on the eye in the desired orientation. In Figure 4, the lower segment 10 is formed with two thickened portions 11. These thickened portions are spaced from the line Y-Y so that when the wearer is looking through the lower part of the near vision portion, his vision will not be disturbed by a thickened portion which is present to maintain the correct orientation of the lens.

To some extent, the lenses of the invention will move on the cornea as the wearer changes his viewpoint between distance and near vision. For example, where the near vision correction is provided by the peripheral region or zone 4, when the wearer looks down to read the lower lid will tend to push the lens up so that a larger proportion of light will enter the cornea from the near vision zone, than from the distance vision zone. However, large amounts of movement of the lens on the cornea tend to upset some contact lens wearers and in the lenses of this invention it is unnecessary for the wearer to be looking exclusively through one type of zone, rather than the other, to achieve good near and distance vision corrections. Good results are obtained where the wearer looks through both zones at the same time, and he will quickly learn to discriminate between the two images since one will be in sharper focus. A small amount of movement can be helpful, particularly where the cornea receives more light or a greater light intensity through the zone appropriate for the vision required at that point. For example, where the wearer switches from distance to near vision, upward movement of the lower eyelid may raise the lens by a small amount, which then causes more light to enter the eye through the near vision zone.

In the case of diffractive lenses of the kind described in US Patent No. 4637697, the surface contours making up the Fresnel zone plate can be shaped so that

the step height is different in one region of the lens from another. As a result, the intensity of light associated with an image seen by diffraction at one order in that region of the lens is greater than the light intensity of the same image, when seen at the same order through other regions of the lens. Thus, for example, the lens surface in the concentric outer region 2 may be formed with zone plate rings having a height such that the intensity of light in, say, the zero order diffraction, has a higher intensity than the intensity of light diffracted by the central region of the lens. In such an embodiment, the distance vision may be provided by refraction produced by the power surface of the lens and near vision by the zone plate rings.

Lenses in accordance with the invention are most conveniently manufactured by moulding. However, they may also be manufactured by machining, polishing or laser ablation. A decentered lens in accordance with the invention may, for example, be cut on a high precision lathe to an overall diameter greater than required, and then cropped to the desired size in such a way that the optical axis of the central region is decentered by the desired amount.

Preferably, lenses in accordance with the invention are manufactured by moulding. This is done by machining a metal mould insert with a high precision computer-controlled lathe, such as a Rank Optoform 50 lathe (available from Taylor, Hobson Pneumo of 2 Star Road, Leicester LE4 9JQ, England. Such a lathe is N.C. controlled and can be digitally programmed to shape the surface of the insert by using a variety of cutting tools, whose position with respect to the work piece is determined by control means which define the position of the tools in relation to X, Y and Z axes. Unlike conventional lathes, the tools are not mounted on radius arms and it is possible to readily cut aspherical surfaces. The shaped metal insert is then used to mould a plastic, e.g. a polypropylene mould, from which the lens if formed by casting, curing and, if water-swellable, by swelling in saline. The shaping of the metal insert is

carried out in such a way that there is no sharp transition between the near and distance vision zones but instead a continuous variation in curvature.

It will be appreciated that a different lens will be required for each eye but this is no disadvantage for patients since it is common to have a different prescription for each eye.

Lenses in accordance with the invention are preferably of the so-called concentric type in which there is a central area surrounded by one or more peripheral areas. it will be appreciated that for the purposes of this invention, the peripheral and central areas will not be strictly concentric. Bifocal lenses of this kind are described, for example, in US Patent No. 4890913 and UK Patent No. 2295686, the disclosure of which is specifically incorporated herein by reference.

In general, the lens construction will fall into the following types and all are included in the present invention.

1. Lenticular surfaces spherical with distance vision in the centre and near vision in the peripheral region.

2. Lenticular surfaces spherical but with near vision in the centre and distance vision in the peripheral area.

3. As in type 1 above but the surfaces are aspherical but R_X gradually changing from distance to reading.

4. As in type 2, but with aspherical surfaces and R_X gradually changing from distance to near vision.

5. Diffractive bifocals as in the lenses sold under the trade marks 'Diffrax' and Echelon and described in US Patent No. 4637697 and European Patent Application No. 0343067.

Although it is currently preferred to provide the distance vision in the central area, an alternative system is to provide one lens with distance vision in the centre and

near vision in a peripheral area, while the lens on the other eye has the near and distance vision areas reversed.

Lenses in accordance with the invention may be 'soft', especially hydrophilic soft contact lenses manufactured from polymers such as those described in British patents Nos. 1385677, 1475605 and 1436705. The polymer is produced in a non-hydrated condition (known as a xerogel) and shaped in this form to provide the power and base curves and the nasally decentered zone. After shaping, the lens is hydrated by swelling in isotonic saline to form the final lens. Alternatively, the lens may be manufactured from hard polymer material, e.g. hard, gas-permeable polymer.

CLAIMS:-

1. A multifocal contact lens which comprises a generally circular first vision zone intended for distance or near vision and an annular second vision zone surrounding said first vision zone and intended for the other of near or distance vision, wherein in use the optical axis of the first zone is displaced nasally with respect to the geometric axis of the lens.

2. A contact lens as claimed in claim 1 in which the first zone is a distance vision zone and the second zone is for near vision.

3. A contact lens as claimed in claim 1 or 2 wherein the optical axes of both zones are displaced nasally with respect to the geometric axes of the lens.

4. A contact lens as claimed in any one of the preceding claims which includes retaining means for retaining the lens oriented on the eye with the optical axis of the fist zone decentered nasally.

5. A contact lens as claimed in claim 4 wherein said retaining means comprises a thickened portion of the lens adapted to retain said lens in the desired orientation.

6. A contact lens as claimed in claim 5 wherein the retaining means comprises two or more thickened portions in the lower segment of the lens, said thickened portions being spaced from a vertical line passing through the geometric centre of the lens.

7. A contact lens as claimed in any one of the preceding claims wherein the optical axis of the fist zone is displaced nasally by a distance of about 0.05 to 1.5 mm.

8. A contact lens as claimed in any one of the preceding claims wherein the circular zone is surrounded by a plurality of annular vision zones, each zone being adapted alternately for distance or near vision.

9. A contact lens as claimed in any one of the preceding claims wherein the annular vision zone or zones are essentially concentric with the first vision zone.

10. A multi-focal contact lens having a geometric axis passing through the centre of the lens, said lens comprising a multiplicity of concentric rings forming a zone plate which provides by diffraction, optionally, together with refraction, at least two distinct foci, one of which provides for near vision and the other for distance vision, wherein one or more of the foci are displaced nasally with respect to said geometric axis.

11. A contact lens as claimed in claim 10 wherein distance vision is provided by refractive power and near vision is provided by said zone plate.

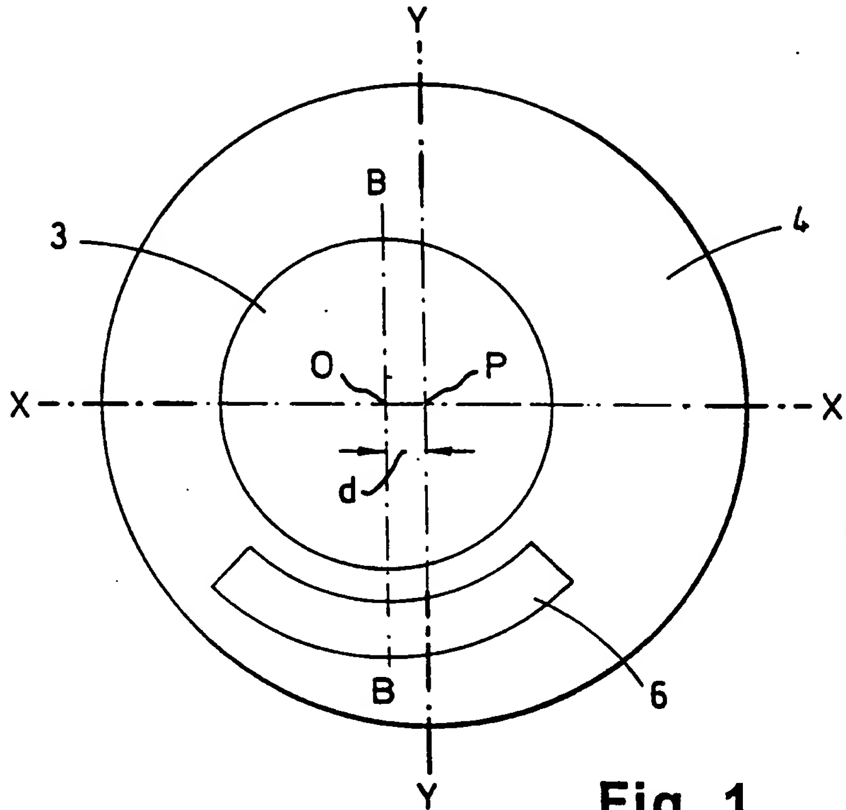


Fig. 1

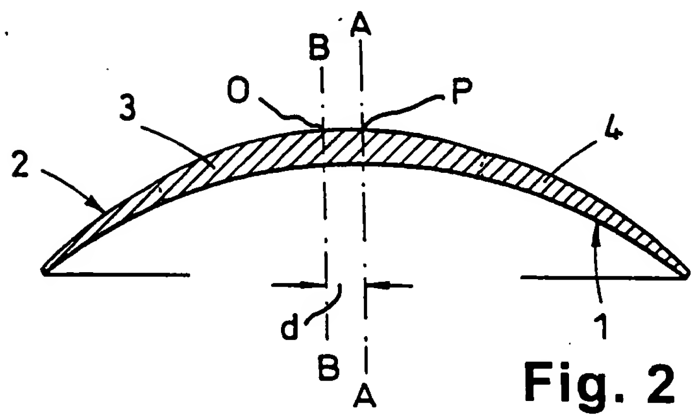


Fig. 2

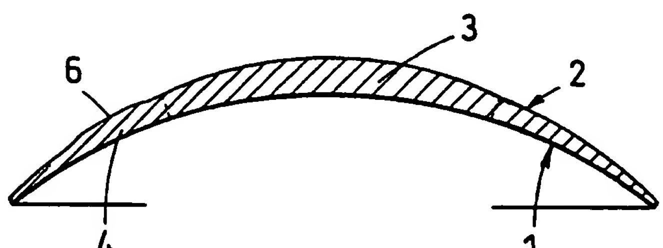


Fig. 3

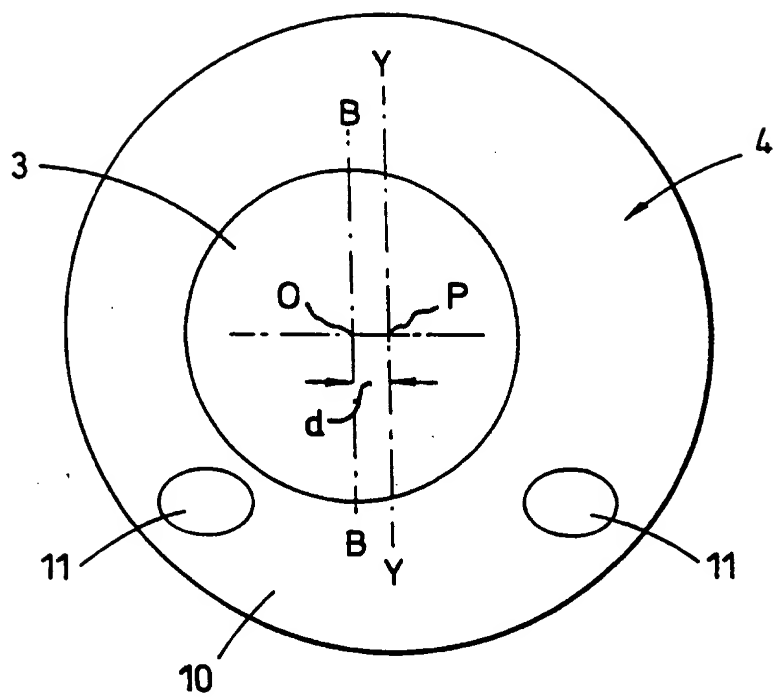


Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/01466

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02C7/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 618 474 A (MENICON CO LTD) 5 October 1994 see column 2, line 35 - column 4, line 24 ---	1-4,7,8
A	EP 0 457 553 A (IOLAB CORP) 21 November 1991 see abstract see column 6, line 3 - line 15 ---	1,9-11
A	US 4 869 587 A (BREGER JOSEPH L) 26 September 1989 see column 7, line 67 - column 9, line 6 ---	1-9
A	EP 0 732 608 A (CIBA GEIGY AG) 18 September 1996 see column 8, line 19 - line 56 ---	1,4
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 1998	03/09/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	CALLEWAERT, H

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/01466

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 756 189 A (JOHNSON & JOHNSON VISION PROD) 29 January 1997 see abstract	1,8,9

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 98/01466

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0618474 A	05-10-1994	JP 7239459 A	12-09-1995
		JP 6289329 A	18-10-1994
		US 5422687 A	06-06-1995
EP 0457553 A	21-11-1991	US 5096285 A	17-03-1992
		AU 7649491 A	17-02-1994
		MX 174633 B	30-05-1994
		NZ 238077 A	27-09-1994
		PT 97656 A	30-07-1993
US 4869587 A	26-09-1989	NONE	
EP 0732608 A	18-09-1996	AU 4796796 A	26-09-1996
		CA 2171697 A	16-09-1996
		JP 8262377 A	11-10-1996
		NO 961047 A	16-09-1996
		US 5760870 A	02-06-1998
EP 0756189 A	29-01-1997	US 5682223 A	28-10-1997
		AU 694341 B	16-07-1998
		AU 5206996 A	14-11-1996
		BR 9602152 A	30-12-1997
		CA 2175652 A	05-11-1996
		CN 1171557 A	28-01-1998
		HU 9601157 A	28-01-1997
		JP 9047463 A	18-02-1997
		NO 961801 A	05-11-1996
		SG 47134 A	20-03-1998